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**TYRONE CLOSURE/CLOSEOUT PLAN
2007 UPDATE**

**BASIS OF COST ESTIMATE FOR
WATER MANAGEMENT AND TREATMENT**

October 2007

073-80012

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1.0 INTRODUCTION

This report presents the cost estimate bases for the proposed mine-wide water management and treatment portion of the Phelps Dodge Tyrone Inc. (Tyrone) Closure/Closeout Plan (CCP) Update. The components of water management and treatment include the following:

- water collection and handling for 100 years;
- a process solution elimination system for treatment of highly contaminated process water, seepage and runoff water during the first five years after closure;
- membrane and lime/high density sludge (HDS) processes for treatment of impacted seepage and runoff for years 5 through 100; and
- a disposal system for sludge produced by the lime/HDS system.

During the first five years after closure, a process solution elimination system will be in place to evaporate the process water inventory existing at closure, plus the runoff and seepage from the uncovered leached stockpiles, water extracted from the pit sumps, and impacted groundwater from groundwater extraction systems. The basis for the process solution elimination system cost estimates is a 2006 study by M3 Engineering and Technology Corporation, *Process Solution Elimination Study* (M3, 2006). At the end of year five, as the leached stockpiles are covered and drain down has decreased significantly, the runoff and seepage will be routed to the water treatment system.

The basis for cost estimation for the water treatment system is the water treatment process flow diagram (PFD) developed by Van Riper Consulting in 2002 (*Van Riper Consulting, 2002*). The PFD includes membrane filtration and lime/high density sludge (HDS) precipitation as the primary processes for metals and sulfate removal. The low sulfate water sources will be treated in the membrane system, and the reject from the membrane system (20% of the forward flow) will be combined with the high sulfate sources and sent to the lime/HDS system for further treatment. The combined membrane permeate (clean) stream and the treated water from the lime/HDS process will meet the regulatory criteria for discharge (600 mg/l sulfate). A flow diagram of the water treatment system is presented in Figure 1.

The following sections present an overview of the modeling results for projection of flow and water quality as well as the capital and operating and maintenance (O&M) cost bases for the process solution elimination system, the water treatment system, and the sludge handling facility. The power and O&M costs associated with water collection are included in the process solution elimination

O&M costs for the first five years following closure and in the water treatment O&M costs for the next 95 years following closure. Total capital and O&M costs are arrived at by summing the subsystem costs.

2.0 QUANTITY AND QUALITY OF WATER TO BE TREATED

There are four sources of water that are likely to be sent to the proposed water treatment system: 1) residual process leach solution (PLS) from the leach operations, 2) meteoric water that infiltrates through the stockpiles to seepage collection, 3) storm water runoff that comes into contact with stockpiles or tailing piles, and 4) groundwater that is impacted by stockpiles or tailing piles. Surface water (runoff and seepage flows) and groundwater will be managed and or treated throughout site reclamation activities and for a duration of 100 years following cessation of mining operations.

The design basis for the proposed water treatment system was derived from implementation of a conceptual mathematical dynamic system model (DSM) using the GoldSim simulation software platform and the proposed reclamation plan presented in this updated CCP. The DSM is a dynamic, probabilistic simulation model that projects the behavior of the mine system and the influence various closure activities have on its performance. Based on comments received from NMED and MMD, the model was run deterministically using expected values for the input parameters. DSM results that are used as “inputs” for water treatment design include the predicted flow rates and sulfate concentrations of waters collected for treatment.

The DSM segregates runoff into impacted (contaminated) and non-impacted (clean) flows. Runoff from covered and regraded stockpile surfaces is assumed to be non-impacted and eventually discharged to the environment (i.e., not sent to the water treatment system). Water quality has a defining role in which water treatment technology can effectively meet established limits. Water quality is also key to operating costs of all technologies, with high concentration waters being more expensive to treat. By separating the transient, process-related waters from the longer-term, better quality waters, specific technologies can be applied to each of the waters. Therefore, one of the objectives of the water treatment system for the Tyrone Mine is to separate the process-related impacts, which are transient and represent poorer quality water, from the longer-term, steady-state background conditions, and to treat them separately.

The projected rate and quality of the influent to the water treatment plant over a 100-year simulation period was based on the CCP design drawings and associated areas presented in Appendix A. The projections do not include process solutions at the end of mining which are assumed to be eliminated using the process solution elimination system (see Section 4.0). Table 1 presents a summary of the modeled flow rates and sulfate concentrations in years 5, 10, 15, 25, 32, 40, and 100 for low and high sulfate waters.

Table 1. Water Flow Rates and Concentrations

Year	Low Sulfate Water		High Sulfate Water	
	Flow Rate (gpm)	Sulfate (mg/l)	Flow Rate (gpm)	Sulfate (mg/l)
5	2,032	2,288	200	32,194
10	1,895	2,549	200	28,238
15	2,088	2,349	169	27,257
25	1,912	2,139	106	23,555
32	1,902	1,935	103	23,255
40	1,884	1,732	103	23,255
100	1,880	1,475	103	23,255

Nominal treatment throughput capacities and sulfate concentrations projected to primary components of the water treatment system are shown on Table 2 for Year 5, the first year of water treatment system operations.

Table 2. Year 5 Influent to Water Treatment System

Process Stream	Flow Rate (gpm)	Sulfate (mg/l)
Low Sulfate Influent (Feed to Membrane System)	2,023	2,288
High Sulfate Seepage (Direct to Lime/HDS)	200	32,194
Membrane Reject (To Lime/HDS)	406	11,212
Combined High Sulfate Seepage and Membrane Reject (Feed to Lime/HDS System)	606	18,140

3.0 BASIS FOR COST ESTIMATE– MEMBRANE AND LIME/HDS TREATMENT

3.1 Capital Cost Estimate

The primary sources for capital cost estimation for the membrane system were treatability studies and a vendor estimate prepared in 2002 (Van Riper Consulting, 2002). The costs were escalated annually by 3.17% per year to project 2007 capital costs. The costs numbers were also revised to reflect a projected decrease in flow from 2800 gpm to 2100 gpm (the membrane design flow to accommodate a projected flow to the membrane system at year 5 of 2032 gpm). The primary source for the capital cost estimate for the lime/HDS system is an earlier cost estimate developed for the Summitville Mine site (RTG, 2004). Summitville is a “Superfund” cleanup site, with long-term water treatment being jointly funded by the U.S. Environmental Protection Agency (USEPA) and the Colorado Department of Public Health and Environment (CDPHE). The RTG (2004) cost estimate was for a new treatment system, replacing an existing system and based on a series of treatability studies to determine optimal treatment pH and HDS system design parameters. The Summitville design and estimate exhibit parallels to Tyrone’s, including nominal flow rate and water quality characterization, and utilizes similar technology for removal of mining-derived contaminants with a permitted effluent discharge to surface water (RTG, 2004). The similarities in process between the Summitville and the Tyrone water treatment designs, level of detail, and relatively recent preparation lend viability to the Summitville estimate as a basis for the Tyrone estimate.

Costs for common process components such as reaction tanks, mixers, flocculation tanks, reagent tanks, pumps, lime addition subsystem components, sludge tanks and ancillary equipment were scaled from the Summitville estimate and escalated for inflation (2004 dollars escalated to 2007). The clarifier and belt press are subject to cost impacts other than inflation, and new estimates were obtained for these items (Sepco, 2007). Utility and ancillary equipment items were estimated as lump sums and include the following: electrical equipment, pipe, fittings, valves, instrumentation, and controls.

Equipment installation and site construction were estimated based on craft personnel, labor hours and prevailing wage rate. Other costs, including mobilization/demobilization, freight, and commissioning were estimated as lump sums. These costs are estimated based on engineer’s judgment and previous Golder experience with treatment plant construction and equipment installation projects. Finally indirect costs including contingency, subcontractor overhead and profit, design, construction

management, and New Mexico Reclamation Fee were applied at project standard factors of the total direct cost. The total capital cost estimate for the membrane and lime/HDS plant is \$15,818,000 and the detail is presented in Table 3.

3.2 Operations and Maintenance Costs

O&M costs include labor, reagents, sludge disposal, capital for equipment replacement, routine maintenance parts cost, sampling and analysis costs, and electrical power. The O&M costs also include the water collection and handling power and maintenance labor. The cost bases for these items are as follows.

Labor. Operations labor (nine full-time equivalents, or FTE), supervision (one FTE), and maintenance staffing (two FTE) levels were estimated based on Golder experience with operations of similar treatment plants. Labor rates and markup for benefits for all categories were based on previous Chino (M3, 2001a) and Tyrone (M3, 2001b) CCPs and experience in the operations of similar systems at former mine sites in the Western US. Overtime was estimated based on Golder experience with operations of similar facilities.

Reagents. Reagents needed for lime/HDS processing include lime, flocculent and acid. Lime is required for chemical precipitation of dissolved metals and sulfate in the influent water and polishing for manganese in the membrane permeate. Projected lime consumption in the O&M cost estimate was based on the 2002 treatability study (Van Riper Consulting, 2002) and adjusted based on the increased sulfate loading to the lime/HDS system. The precipitated metals and sulfate are separated in the clarifier into the sludge underflow, leaving a clarified water overflow that has greatly reduced contaminant concentrations. Lime unit cost is based on a vendor quote (Chemical Lime Company, 2007). The lime cost is based on the projected lime consumption values, and it is possible that a discounted price could be negotiated with a vendor.

Flocculent is added to increase the settling rate of precipitated solids and later in the process to increase the efficiency of sludge densification (water removal) in the belt press. A relatively small dose of flocculent is required as a settling aid, while a much greater quantity is required at the belt press. The trade-off in cost benefit is in final sludge disposal volume. A final sludge waste that is approximately 50 percent solids can be produced in a flocculent-aided belt press on a continuous basis. The alternative is to dewater the sludge in a filter press with no flocculent addition. Utilization of a filter press is more labor intensive, requiring batch-wise operation of filling and

emptying the press and it produces a final sludge waste that may be lower in solids content and higher in volume than the final sludge from the belt press. Flocculent cost was obtained by vendor quote and usage rates were based on operational experience at other mine sites and vendor recommendations (Ciba, 2007).

Sulfuric acid is used to adjust effluent pH of the lime treated clarified water. Lime treatment for precipitation of metals and sulfate requires a pH of approximately 10. The effluent discharge limit for pH requires a range of 6 to 9. Acid is added and mixed inline to control effluent pH within the discharge limit range. Since the treated water from the lime/HDS system is to be mixed with the lower pH/low buffer capacity permeate from the membrane system, the acid consumption will be lower than a typical lime/HDS effluent. Usage is based on the values reported in the 2002 treatability study (Van Riper Consulting, 2002).

Sludge disposal. The cost of sludge disposal from the “*Preliminary Sludge Handling Plan and Cost Estimate* (Van Riper Consulting, 2004) completed for Tyrone is estimated at \$0.13 per cubic foot of 50 percent solids sludge. This cost includes loading, hauling and unloading of sludge in an onsite sludge disposal facility. The sludge volume is calculated based on the results of treatability studies and modeling for predicted plant influent in years 5, 10, 15, 25, 32, 40, and 100 at the lime/HDS treatment plant. The computer modeling predictions show lower flow rates and changes in water chemistry which decrease the rate of sludge production through the operational life of the treatment plant. The “out-year” O&M costs account for the gradual reduction in sludge production.

Capital replacement and routine maintenance parts. Through the duration of plant operations, equipment will be routinely maintained by replacing “wear” parts and by less frequently replacing entire components (pumps, mixers, etc) due to life cycle failure. Capital replacement and routine maintenance parts are estimated as percentages of the capital cost estimate. Routine maintenance parts are factored at 1 percent of the estimated total constructed cost and capital replacement is factored at 1.5 percent of the estimated total constructed cost. These factors are based on experience at other sites and the estimates completed for the Summitville Mine site (RTG, 2004).

Sampling and analysis. Sampling and analysis is required for compliance with effluent discharge permit conditions and for measurement of plant performance. Analyses required by permit and the frequency at which the analyses are to be performed are incorporated into the O&M cost estimate. Through the duration of water treatment operations, the frequency of sampling and analysis required drops from quarterly to semi-annually to annually. The change in number of samples collected and

analyzed is accounted for in the long-term O&M cost estimate. No labor cost is assigned to the sampling effort. It is assumed that the sampling will be a routine duty for plant operators. Analytical costs are estimated based on laboratory pricing guide (Energy Laboratories Inc., 2007). Costs are inclusive of packaging, handling, shipping, quality assurance/quality control and lab results report preparation.

Electrical power consumption. Electrical power is estimated based on development of a motor list, motor efficiency and operating diversity (run time), similar to the methodology used in the Tyrone CCP (M3, 2001b). Total kilowatt-hours (kWh) per year are calculated and summed, and a unit cost of \$0.06 per kWh is used to estimate total electrical power cost in year one of operations. In out-years, the power consumption is scaled down in direct proportion to the decreasing flow rate through the plant. The power consumption includes the water treatment equipment as well as the collection system pumps.

3.3 Membrane and Lime/HDS Treatment 100 Year O&M Cost

The O&M costs as described above were calculated for operational years 5, 10, 15, 25, 32, 40, and 100. Changes in flow rate and water chemistry, as predicted by DSM, are carried into the calculation of reagent use and electrical power consumption. O&M costs for these years are presented in Tables 3 through 10.

A total estimated O&M current cost was calculated by straight line interpolation between the “time step” years (years 5, 10, 15, 25, 32, 40, and 100). (The first five years of O&M costs are limited to water handling power required by the process solution elimination system). The interpolation of O&M costs between time step years provides an annual O&M cost estimate for interim years between time steps (years 6 through 9, years 11 through 14, etc). The subsystem O&M cost estimate summed for 95 years of operation for the membrane and lime/HDS treatment plant and collection system pumping is \$275,632,000. This cost is based on current dollars and does not include escalation or discount rate.

4.0 BASIS FOR COST ESTIMATE—PROCESS SOLUTION ELIMINATION SYSTEM

The process solution elimination system will be used during the first five years after closure to evaporate the process water inventory existing at closure, plus the runoff and seepage from the uncovered leached stockpiles, water extracted from the pit sumps, and impacted water from groundwater extraction systems. The *Process Solution Elimination Study* (M3, 2006) discusses alternatives for the treatment of 1.8 billion gallons of inventoried process waters resulting from mine closure. The selected alternative (Alternative 2) pumps collected waters to the top surface of the 2A leach stockpile and distributes the water through a network of drip irrigation pipelines. Evaporation will occur from the wetted surface of the leach pile top and the surface of the process water reservoirs/impoundments. Note that the pit interceptor wells and associated costs included in the *Process Solution Elimination Study* (M3, 2006) have been eliminated from this system. The primary purpose of these wells was to reduce the inflow of ground water to the pits discharge the unimpacted, intercepted water elsewhere so that it would not become impacted in the pits and require treatment. The pit inflows that are applied in the DSM and during the first five years of closure in this analysis do not account for the interception of groundwater from these wells. Therefore, the flow rates are higher to water treatment than would be realized if the interceptor wells were in place. So while the capital and O&M cost estimates included herein, do not include the costs associated with this type of interceptor wells, the capital and O&M are higher for water treatment than they would be if the interceptor wells were assumed to be in place and operating. Tyrone plans to continue to evaluate these type of interceptor wells for their application in future closure activities.

4.1 Capital Cost Estimate

The *Process Solution Elimination Study* (M3, 2006) has documented the capital cost estimate for the evaporation alternative described above. The total constructed cost of the Tyrone process solution elimination system alternative was estimated at \$7,828,806. Escalating this estimate to 2007 dollars provides the current capital cost estimate of \$8,077,000.

4.2 Operations & Maintenance Costs

The *Process Solution Elimination Study* (M3, 2006) also provides an estimate of annual operations cost at \$4,655,443 for the first year with decreases through the next 4 years as the flows decrease.

As with the capital cost estimate, the process solution elimination system O&M costs were escalated to reflect 2007 costs.

4.3 Process Solution Elimination System Estimated 100 Year O&M Costs

The process solution elimination system will operate only as long as necessary to eliminate the bulk of the process solutions in inventory at the cessation of mining operations. This operational period is estimated at five years. The total O&M cost estimate is derived by summing the estimated annual O&M costs as described above and is estimated at \$11,809,000. Upon shutdown of the process solution elimination system and reclamation of the leached stockpiles, long-term seepage will be treated through the membrane and lime/HDS treatment facility.

5.0 BASIS FOR COST ESTIMATE–SLUDGE DISPOSAL FACILITY

5.1 Capital Cost Estimate

The sludge disposal facility will be developed on site. The capacity of the disposal facility is adequate for sludge produced for 95 years of operation of lime/HDS treatment plant. The capital cost is estimated by scaling from known cost for a similar proposed sludge disposal facility at Tyrone (Van Riper Consulting, 2004). The capital costs are increased to accommodate changes in sludge volume due to increases in the sulfate concentrations of the incoming water to the water treatment facility. The capital costs are escalated using the ratio of the current projected sludge volume to the sludge volume projected in 2004 to the 0.6 power (a common engineering escalation factor to account for economies of scale).

5.2 Operations and Maintenance Costs

The O&M costs for the sludge disposal facility are incorporated into the membrane and lime/HDS treatment plant O&M costs as described in Section 3.2, Sludge Disposal.

5.3 Sludge Disposal Facility Estimated 100 Year O&M Cost

The O&M costs developed for sludge disposal within the membrane and lime/HDS plant O&M costs were calculated for operational years 5, 10, 15, 25, 32, 40, and 100. Sludge quantities were calculated based on water flow rate and chemistry, and treatability studies. Changes in flow rate and water chemistry as predicted by DSM modeling are carried into the calculation of sludge production.

A total estimated sludge disposal O&M current cost was calculated by straight line interpolation between the “time step” years.. This calculation also provides an annual O&M cost estimate for interim years between time steps (years, 6 through 9, years, 11 through 14, etc.).

The subsystem O&M cost estimate for sludge generated summed for 95 years of operation is \$15,594,000.

6.0 TOTAL COST ESTIMATE FOR WATER TREATMENT

Capital cost estimates for each of the three subsystems that together comprise the Tyrone water treatment system were summed to generate a total capital cost estimate of \$25,483,000.

O&M cost estimates for each of the three subsystems were developed as described in the previous sections, along with electrical power requirements for water handling, and were summed for years 0 through 100. The current cost for 100 years of operation is then summed from the capital cost estimates applied in year five and all O&M annual cost estimates (year 0 through 100). Summary capital and current costs for 100 years of O&M are presented in Table 11 and are \$328,518,000.

7.0 REFERENCES

Chemical Lime Company, 2007. Personal communication with Brett Tanner, June 20, 2007.

Ciba Specialty Chemicals, 2007. Personal communication with Jerry Goelge, July 6, 2007.

Energy Laboratories, Inc, 2007. Published price list for analytical work. Available via internet at www.energylab.com.

M3 Engineering and Technology Corporation (M3). 2001a. Tyrone Closure/Closeout Plan. March 17, 2001.

M3, 2001b. Tyrone Closure/Closeout Plan. May 8, 2001.

M3, 2006. Process Solution Elimination Study. Updated 2006.

RTG, 2004. Summitville Mine Superfund Site Operable Unit 5 Water Treatment Plant Construction Documents Report.

Sepco, 2007. Personal communication with John Smith.

Van Riper Consulting, 2002, "Tyrone Post-Closure Water Treatment System Engineered Membrane Alternative, April 27, 2002.

Van Riper Consulting, 2004, Preliminary Sludge Handling Plan and Cost Estimate DP-1341 Condition 86, October 22, 2004.

TABLES

**TABLE 3
CAPITAL COST ESTIMATE FOR MEMBRANE AND LIME/HDS TREATMENT FACILITY**

Tyrone CCP Capital Cost Estimate Summary

Revision: 1
Date: 10-Oct-07

Membrane System Influent 2100 gpm
Membrane System Recovery 80 %
Membrane System Capacity, permeate 1680 gpm
Lime System Capacity 750 gpm

Item	Description	Qty	UOM	Unit \$	Extended
Equipment Cost					
Reaction Tank #1		1	each	\$ 50,000	\$ 50,000
Reaction Tank Mixer #1		1	each	\$ 30,000	\$ 30,000
Floc Tank #1		1	each	\$ 20,000	\$ 20,000
Floc Tank Mixer #1		1	each	\$ 10,000	\$ 10,000
Mixing Tank #1		1	each	\$ 20,000	\$ 20,000
Mixing Tank Mixer #1		1	each	\$ 8,000	\$ 8,000
Thickener/Clarifier #1		1	each	\$ 730,000	\$ 730,000
Sludge Pump #1		2	each	\$ 14,000	\$ 28,000
Underflow Pump #1		2	each	\$ 17,000	\$ 34,000
Polymer system		1	each	\$ 68,000	\$ 68,000
Lime Silo and Slaker System		1	each	\$ 325,000	\$ 325,000
pH Control System (Acid addition)		1	each	\$ 51,000	\$ 51,000
Sludge Holding Tank		1	each	\$ 100,000	\$ 100,000
Sludge Holding Tank Mixer		1	each	\$ 36,000	\$ 36,000
Belt Press		1	each	\$ 375,000	\$ 375,000
Belt Press Wash Pump		1	each	\$ 32,000	\$ 32,000
Belt Press Waste Pump		1	each	\$ 32,000	\$ 32,000
Belt Press Polymer System		1	each	\$ 45,000	\$ 45,000
Belt Press Cake Handling Conveyor		1	each	\$ 75,000	\$ 75,000
Wash Tank		1	each	\$ 22,000	\$ 22,000
Process Water Tank		1	each	\$ 22,000	\$ 22,000
Process Water Return Pump		2	each	\$ 10,000	\$ 20,000
Air Compressor		1	each	\$ 42,000	\$ 42,000
Air Receiver		1	each	\$ 7,000	\$ 7,000
Electrical Equipment		1	ls	\$ 150,000	\$ 150,000
Valves		1	ls	\$ 80,000	\$ 80,000
Instrumentation		1	ls	\$ 40,000	\$ 40,000
Control System		1	ls	\$ 120,000	\$ 120,000
Membrane System Equipment					\$ 2,446,000
Total Direct Equipment					\$ 5,018,000
Installation Cost					
Equipment Placement	Materials/equipment	1	ls	\$45,000	\$ 45,000
	Crew size 6 men				
	Duration 66 days				
	Labor subtotal	3,168	hrs	\$30	\$ 95,040
Tank Erection	Materials/equipment	1	ls	\$ 125,000	\$ 125,000
	Crew size 8 men				
	Duration 110 days				
	Labor subtotal	7,040	hrs	\$30	\$ 211,200
Process Mechanical	Materials/equipment	1	ls	\$ 160,000	\$ 160,000
	Crew size 10 men				
	Duration 154 days				
	Labor subtotal	12,320	hrs	\$30	\$ 369,600
Process Electrical	Materials/equipment	1	ls	\$ 135,000	\$ 135,000
	Crew size 8 men				
	Duration 132 days				
	Labor subtotal	8,448	hrs	\$30	\$ 253,440
Process Controls	Materials/equipment	1	ls	\$ 95,000	\$ 95,000
	Crew size 6 men				
	Duration 88 days				
	Labor subtotal	4,224	hrs	\$30	\$ 126,720
Structural Steel		1	ls	\$150,000	\$ 150,000
Membrane System Install					\$ 1,336,000
Total Installation Cost					\$ 3,102,000
Facility Cost					
Site Work		1	allow	\$150,000	\$ 150,000
Foundations	Pad area 16000 ft2				
	Average thickness 2 ft				
	Foundation wall width 1 ft				
	Foundation wall depth 3 ft				
	Footer width 3 ft				
	Footer depth 1 ft				
	Additional allowance 25 %				
	Total concrete	1,569	cy	\$500	\$ 784,661
Building Envelope	Building area 16000 ft2	16,000	ft2	\$100	\$ 1,600,000
Building Electrical	Materials/equipment	1	ls	\$150,000	\$ 150,000
	Crew size 6 men				
	Duration 88 days				
	Labor subtotal	4,224	hrs	\$30	\$ 126,720
Building Plumbing		1	ls	\$20,000	\$ 20,000
Building HVAC		1	ls	\$70,000	\$ 70,000
Total Facility Cost					\$ 2,901,000
Other Project Costs					
Mobilization/Demobilization		1	ls	\$50,000	\$ 50,000
Freight		2	%	\$5,018,000	\$ 100,360
Commissioning		1	ls	\$250,000	\$ 250,000
		0	ls	\$0	\$ -
		0	ls	\$0	\$ -
Total Other Project Costs					\$ 400,000
Total Capital Cost					
Total Direct Cost					\$ 11,421,000
Indirect Costs					
Contingency		2	%	\$11,421,000	\$ 228,420
Subcontractor General Conditions		0	%	\$11,421,000	\$ -
Subcontractor Overhead		21	%	\$11,421,000	\$ 2,398,410
Subcontractor Profit		4	%	\$11,421,000	\$ 456,840
Design		5	%	\$11,421,000	\$ 513,945
Construction Management/Controls		5	%	\$11,421,000	\$ 571,050
New Mexico Reclamation Fee		2	%	\$11,421,000	\$ 228,420
Bonds		0	%	\$11,421,000	\$ -
Total Capital Cost					\$ 15,818,000

**TABLE 4
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 5**

Tyrone Closure/Closeout Plan								
Operating Cost - Membrane filtration / HDS Plant Year 5				Cover Alternative II				
Year - 5 Following Cessation of Operation			2,032 gpm to Membrane			607 gpm to Lime HDS		
Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	607	79.38	lbs./1,000 gallons	12,700	Ton	\$ 114.50	Ton	\$ 1,454,150
Polymer (Flocculant)	607	1.90	lbs./1,000 gallons	605,400	lb	\$ 1.65	lb	\$ 998,910
Effluent pH Adjust	607	0.03	lbs./1,000 gallons	8,900	lb	\$ 0.50	lb	\$ 4,450
Sub-total Water Treatment Facilities Reagent Cost								\$ 2,457,510
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ 21,700
Sub-total Sampling & Analytical								\$ 21,700
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		2,080,467	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 270,461
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling			Usage	Units		Cost	Unit	
			6,972,279	kWh		0.0600	\$/kWh	\$ 418,337
Electric Power to Membrane System			1,056,261	kWh		0.0600	\$/kWh	\$ 63,376
Electric Power to Lime / HDS System			1,744,048	kWh		0.0600	\$/kWh	\$ 104,643
Sub-total Water Facilities Electric Power								\$ 586,356
Total Annual Water Treatment Facilities Operating Cost								\$ 4,222,149

**TABLE 5
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 10**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 10

Cover Alternative II

Year - 10 Following Cessation of Operation

1,895 gpm to Membrane

579 gpm to Lime HDS

Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	579	78.44	lbs./1,000 gallons	11,900	Ton	\$ 114.50	Ton	\$ 1,362,550
Polymer (Flocculant)	579	1.89	lbs./1,000 gallons	574,000	lb	\$ 1.65	lb	\$ 947,100
Effluent pH Adjust	579	0.03	lbs./1,000 gallons	8,500	lb	\$ 0.50	lb	\$ 4,250
Sub-total Water Treatment Facilities Reagent Cost								\$ 2,313,900
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ 45,500
Sub-total Sampling & Analytical								\$ 45,500
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		2,020,290	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 262,638
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		6,540,725	kWh			0.0600	\$/kWh	\$ 392,443
Electric Power to Membrane System		984,731	kWh			0.0600	\$/kWh	\$ 59,084
Electric Power to Lime / HDS System		1,663,311	kWh			0.0600	\$/kWh	\$ 99,799
Sub-total Water Facilities Electric Power								\$ 551,326
Total Annual Water Treatment Facilities Operating Cost								\$ 4,059,486

**TABLE 6
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 15**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 15

Cover Alternative II

Year - 15 Following Cessation of Operation

2,088 gpm to Membrane

586 gpm to Lime HDS

Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	586	70.18	lbs./1,000 gallons	10,800	Ton	\$ 114.50	Ton	\$ 1,236,600
Polymer (Flocculant)	586	1.78	lbs./1,000 gallons	547,400	lb	\$ 1.65	lb	\$ 903,210
Effluent pH Adjust	586	0.03	lbs./1,000 gallons	8,600	lb	\$ 0.50	lb	\$ 4,300
Sub-total Water Treatment Facilities Reagent Cost								\$ 2,144,110
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ 29,300
Sub-total Sampling & Analytical								\$ 29,300
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		1,869,269	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 243,005
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		7,046,595	kWh			0.0600	\$/kWh	\$ 422,796
Electric Power to Membrane System		1,085,177	kWh			0.0600	\$/kWh	\$ 65,111
Electric Power to Lime / HDS System		1,684,521	kWh			0.0600	\$/kWh	\$ 101,071
Sub-total Water Facilities Electric Power								\$ 588,978
Total Annual Water Treatment Facilities Operating Cost								\$ 3,891,515

**TABLE 7
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 25**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 25

Cover Alternative II

Year - 25 Following Cessation of Operation

1,912 gpm to Membrane

488 gpm to Lime HDS

Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	488	58.28	lbs./1,000 gallons	7,500	Ton	\$ 114.50	Ton	\$ 858,750
Polymer (Flocculant)	488	1.54	lbs./1,000 gallons	394,200	lb	\$ 1.65	lb	\$ 650,430
Effluent pH Adjust	488	0.03	lbs./1,000 gallons	7,200	lb	\$ 0.50	lb	\$ 3,600
Sub-total Water Treatment Facilities Reagent Cost								\$ 1,512,780
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ 18,100
Sub-total Sampling & Analytical								\$ 18,100
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		1,490,333	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 193,743
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		6,301,580	kWh			0.0600	\$/kWh	\$ 378,095
Electric Power to Membrane System		993,701	kWh			0.0600	\$/kWh	\$ 59,622
Electric Power to Lime / HDS System		1,403,543	kWh			0.0600	\$/kWh	\$ 84,213
Sub-total Water Facilities Electric Power								\$ 521,930
Total Annual Water Treatment Facilities Operating Cost								\$ 3,132,675

**TABLE 8
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 32**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 32

Cover Alternative II

Year - 32 Following Cessation of Operation

1,902 gpm to Membrane

483 gpm to Lime HDS

Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	483	54.32	lbs./1,000 gallons	6,900	Ton	\$ 114.50	Ton	\$ 790,050
Polymer (Flocculant)	483	1.35	lbs./1,000 gallons	342,000	lb	\$ 1.65	lb	\$ 564,300
Effluent pH Adjust	483	0.03	lbs./1,000 gallons	7,100	lb	\$ 0.50	lb	\$ 3,550
Sub-total Water Treatment Facilities Reagent Cost								\$ 1,357,900
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ 18,100
Sub-total Sampling & Analytical								\$ 18,100
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		1,181,344	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 153,575
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		6,261,568	kWh			0.0600	\$/kWh	\$ 375,694
Electric Power to Membrane System		988,667	kWh			0.0600	\$/kWh	\$ 59,320
Electric Power to Lime / HDS System		1,388,987	kWh			0.0600	\$/kWh	\$ 83,339
Sub-total Water Facilities Electric Power								\$ 518,353
Total Annual Water Treatment Facilities Operating Cost								\$ 2,934,050

**TABLE 9
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 40**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 40

Cover Alternative II

Year - 40 Following Cessation of Operation

1,884 gpm to Membrane

480 gpm to Lime HDS

Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	480	51.00	lbs./1,000 gallons	6,400	Ton	\$ 114.50	Ton	\$ 732,800
Polymer (Flocculant)	480	1.26	lbs./1,000 gallons	317,500	lb	\$ 1.65	lb	\$ 523,875
Effluent pH Adjust	480	0.03	lbs./1,000 gallons	7,100	lb	\$ 0.50	lb	\$ 3,550
Sub-total Water Treatment Facilities Reagent Cost								\$ 1,260,225
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					
Routine Maintenance								\$ 158,180
Capital Replacement								\$ 237,270
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ -
Sub-total Sampling & Analytical								\$ -
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		1,095,048	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 142,356
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		6,205,043	kWh			0.0600	\$/kWh	\$ 372,303
Electric Power to Membrane System		979,260	kWh			0.0600	\$/kWh	\$ 58,756
Electric Power to Lime / HDS System		1,378,582	kWh			0.0600	\$/kWh	\$ 82,715
Sub-total Water Facilities Electric Power								\$ 513,774
Total Annual Water Treatment Facilities Operating Cost								\$ 2,802,477

**TABLE 10
OPERATING COST - MEMBRANE AND LIME/HDS PLANT YEAR 100**

Tyrone Closure/Closeout Plan

Operating Cost - Membrane filtration / HDS Plant Year 100

Cover Alternative II

Year - 100 Following Cessation of Operation

1,880 gpm to Membrane

479 gpm to Lime HDS

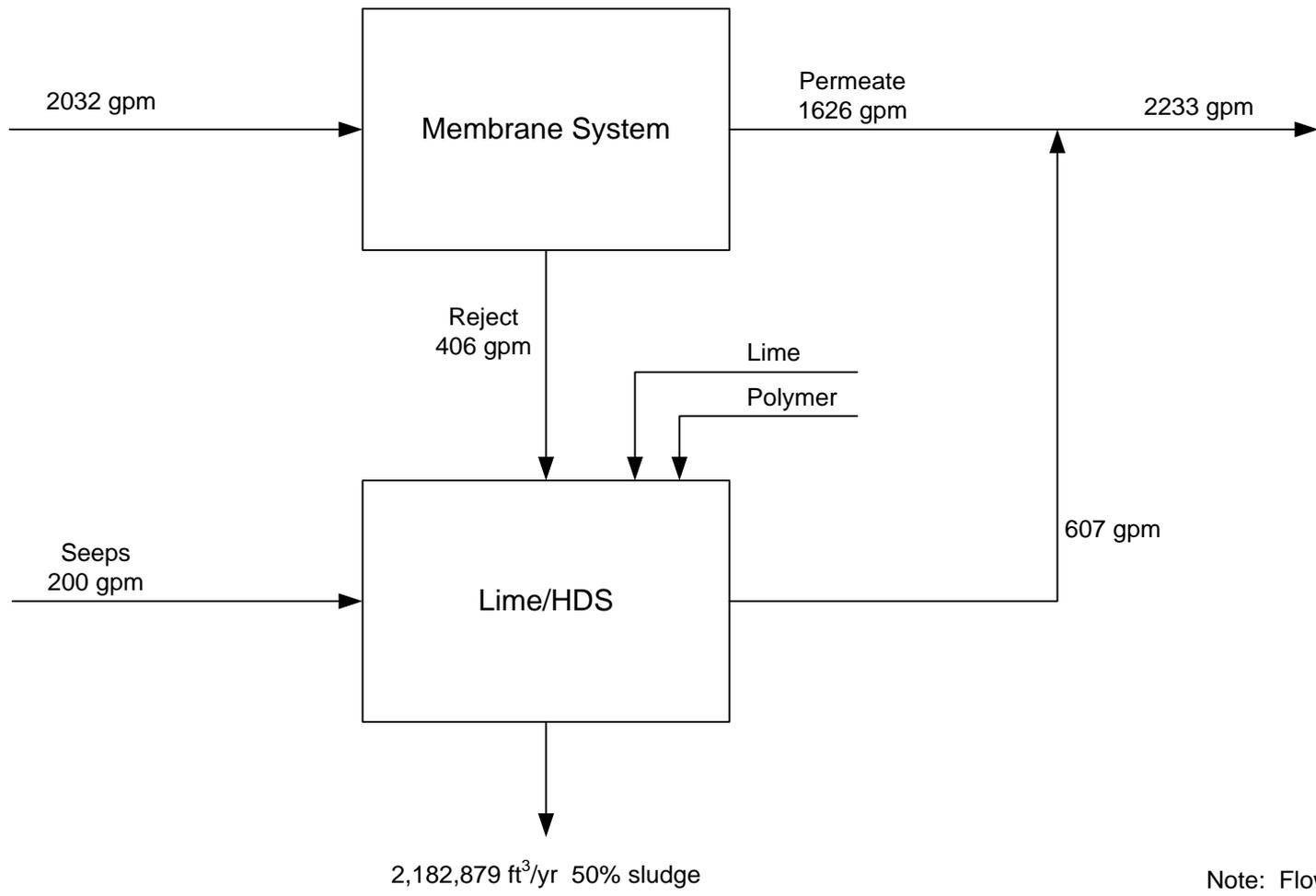
Cost Item	Number of Personnel	Hours per year	Hourly Rate					Annual Cost
Water Treatment Facilities Labor								
Operations Labor	9	2,080	\$ 12.50					\$ 234,000
Operations Supervisor	1	2,080	\$ 20.00					\$ 41,600
Maintenance Labor	2	2,080	\$ 18.00					\$ 74,880
Overtime								35,048
Mandated and Voluntary Labor Benefits								105,144
Sub-total Water Treatment Facilities Labor Cost								\$ 490,672
Cost Item	Treatment Flow Rate (gpm)	Consumption Rate		Annual Consumption		Unit Cost		Annual Cost
		Rate	Unit	Rate	Unit	Cost	Unit	
Water Treatment Facilities Reagents								
Lime	479	46.68	lbs./1,000 gallons	5,900	Ton	\$ 114.50	Ton	\$ 675,550
Polymer (Flocculant)	479	1.17	lbs./1,000 gallons	293,900	lb	\$ 1.65	lb	\$ 484,935
Effluent pH Adjust	479	0.03	lbs./1,000 gallons	7,000	lb	\$ 0.50	lb	\$ 3,500
Sub-total Water Treatment Facilities Reagent Cost								\$ 1,163,985
Cost Item	Total Constructed Cost Estimate	Routine Maintenance	Capital Replacement					Annual Cost
Water Treatment Facilities Parts								
Maintenance	\$ 15,818,000	1.00%	1.50%					\$ 158,180
Routine Maintenance								\$ 237,270
Capital Replacement								
Sub-total Water Treatment Facilities Parts Cost								\$ 395,450
Cost Item								Annual Cost
Water Treatment and Environmental Sampling & Analytical								
Sampling, Sample Analysis, Reporting								\$ -
Sub-total Sampling & Analytical								\$ -
Cost Item		Sludge Generation				Unit Cost		Annual Cost
		Rate	Unit			Cost	Unit	
Sludge Disposal								
		1,010,928	ft ³ /yr			\$ 0.13	\$/ft ³	\$ 131,421
Cost Item								Annual Cost
Water Treatment Facilities Electric Power								
Electric Power for Water Handling		6,192,257	kWh			0.0600	\$/kWh	\$ 371,535
Electric Power to Membrane System		977,132	kWh			0.0600	\$/kWh	\$ 58,628
Electric Power to Lime / HDS System		1,376,229	kWh			0.0600	\$/kWh	\$ 82,574
Sub-total Water Facilities Electric Power								\$ 512,737
Total Annual Water Treatment Facilities Operating Cost								\$ 2,694,264

TABLE 11
CAPITAL AND OPERATIONS AND MAINTENANCE COST ESTIMATE SUMMARY

Tyrone CCP Update
Water Treatment Capital and O&M Cost Estimate Summary

Capital Cost Elements	Cost
Process Solution Elimination	\$ 8,077,000
Membrane and Lime/HDS Plant	\$ 15,818,000
Sludge Disposal Facility	\$ 1,588,000
Subtotal, Capital	\$ 25,483,000
Operations & Maintenance Costs	
Process Solution Elimination	\$ 11,809,000
Electric Power for Water Handling	\$ 39,394,000
Membrane and Lime/HDS Plant	\$ 236,238,000
Sludge Disposal	\$ 15,594,000
Subtotal, Operations and Maintenance	\$ 303,035,000
Total Capital + O&M Estimate	\$ 328,518,000

FIGURES



Note: Flows are at year 5



Denver, Colorado

TITLE
WATER TREATMENT FLOWSHEET

CLIENT/PROJECT
TYRONE CCP UPDATE

DRAWN	PWE	DATE	Oct 2007	JOB NO.	073-80012
CHECKED	BCH	SCALE	Not To Scale	DWG. NO.	NA
REVIEWED	PRL	FILE NO.	J:\07\JOBS\073-80012 Tyrone CCP Update Water Treatment Cost\ Water Treatment Flowsheet.vsd	FIGURE NO.	1